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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/749,022	12/30/2003	Sang Kyun Park	29936/39889	9225

4743 7590 08/06/2004

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EXAMINER	
GURLEY, LYNNE ANN	

ART UNIT	PAPER NUMBER
2812	

DATE MAILED: 08/06/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/749,022	PARK	
	Examiner	Art Unit	
	Lynne A. Gurley	2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

LYNNE A. GURLEY
PRIMARY PATENT EXAMINER
TC 2800, AU 2812

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *12/30/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities:

2. On page 4, [0013], line 2, "a method a method" should be "a method";

3. On page 11, [0038], line 2, "in the case" should be "In this case";

4. On page 11, [0040], lines 3 and 6, "300" is described as "copper anti-diffusion insulating film" when it is actually "copper anti-diffusion conductive film" since Figures 2A-2C are drawn to the embodiment using the copper anti-diffusion insulating film and Figures 3A-3C are drawn to the embodiment using the copper anti-diffusion conductive film.

Appropriate correction is required.

5. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claims 1-2, 7, 13-14, 19, 21-22 and 24 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Wang et al. (US 6,387,806, dated 5/14/02).

8. Wang shows the method as claimed in figures 1-19 and corresponding text, with emphasis on figures 14-15, to show the recess 228 formed by CMP, which produces a surface of the copper wiring 230 lower than the surface of the interlayer insulating film 204. Wang shows the substrate 206, interlayer insulating film 204 with damascene pattern and copper anti-diffusion conductive film 212 and copper layer 230 with the recess 228 (fig. 14) formed by CMP (column 9, lines 9-34), and copper anti-diffusion insulating film or conducting film (additional encapsulating material 222 in fig. 13 SiON, SiN, SiC, metal oxide and/or metal dopant (column 4, lines 20-36; column 7, lines 45-67; column 8, lines 1-54). The metal dopant is deposited with the copper fill by electroless plating.

9. Claims 1 and 9-10 are rejected under 35 U.S.C. 102(b) as being anticipated by Zhou et al. (US 6,251,786, dated 6/26/01).

10. Zhou shows the method as claimed in figures 1-8 and corresponding text, with substrate 10, insulating film 16, damascene pattern 14, anti-diffusion conductive film 20 in the damascene pattern, copper 22, CMP/wet etch step to recess the copper (figs. 3-4) and anti-diffusion insulating film 30.

11. Claim 1 and 9-10 are rejected under 35 U.S.C. 102(b) as being anticipated by Gupta et al. (US 6,274,499, dated 8/14/01).

Gupta shows the method as claimed in figures 5-15 and corresponding text, with substrate 10, insulating film 14, damascene pattern 17, anti-diffusion conductive film 16 in the damascene pattern, copper 26, CMP/wet etch step to recess the copper (figs. 9-10) and anti-diffusion insulating film 30.

12. Claim 13 is rejected under 35 U.S.C. 102(b) as being clearly anticipated by Shue et al. (US 6,083,835, dated 7/4/00).

13. Shue shows the method as claimed in figures 1-4 and corresponding text, with damascene pattern 2/3 in interlayer insulating film 1 (fig. 1); copper anti-diffusion conductive film (column 3, lines 3-8); copper wiring by CMP, wherein the surface of the copper wiring is lower than the surface of the interlayer insulating film (dishing, column 3, lines 9-16); selective formation of a copper anti-diffusion conductive film 21 (electroplating, CVD; column 3, lines 25-39) on the top surface of the copper wiring.

14. Claim 13 is rejected under 35 U.S.C. 102(b) as being clearly anticipated by Toyoda et al. (US 2001/0013617, dated 8/16/01).

15. Toyoda shows the method as claimed in figures 1-11 and corresponding text, with emphasis on figs. 3-4, with damascene pattern 32 (fig. 3A) in interlayer insulating film 32; copper anti-diffusion conductive film 34/35; copper wiring 36 by CMP, wherein the surface of the copper wiring is lower than the surface of the interlayer insulating film (fig. 3D); selective formation of a copper anti-diffusion conductive film 37 (electroplating ruthenium; [0138]-[0140]) on the top surface of the copper wiring.

16. Claims 13-15, 19, 21, 23 and 25 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Saito et al. (US 2003/0109129, dated 6/12/03, filed 12/27/02).

17. Saito shows the method as claimed in figures 1-38 and corresponding text, with emphasis on figures 3-7, with damascene pattern HM1 (fig. 3) in interlayer insulating film 22; copper anti-diffusion conductive film M1a/M1b (fig. 4); copper wiring M1c by CMP (fig. 5), wherein the surface of the copper wiring is lower than the surface of the interlayer insulating film (slight dishing shown in fig. 5, [0107]-[0108]); selective formation of a copper anti-diffusion conductive film CM1 (fig. 6; selective deposition of W; [0109]) on the top surface of the copper wiring. Saito shows that the copper wiring is annealed after the CMP step in a reducing atmosphere [0108]. The CMP process may be performed to concave the top surface of the copper wiring and then an annealing process is performed before and during the deposition of the selective W which will convex the surface, even if only relatively to the concave surface resulting from the CMP [0108]-[0110], [0112] (especially [0110], line 11-18). Cleaning is performed [0113]-[0114]. Heat treatment is performed in a reducing atmosphere with hydrogen or ammonia [0108], [0133] – also includes plasma, [0151]. Other cleaning solutions may be used [0114].

Claim Rejections - 35 USC § 103

18. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

19. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

20. Claims 16-18, 20, 22 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saito et al. (US 2003/0109129, dated 6/12/03, filed 12/27/02).

21. Saito shows the method substantially as claimed and as described in the preceding paragraphs.

22. Saito lacks anticipation only in not teaching that; 1) nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; 2) the annealing process is performed using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process; 3) the plasma process is carried out in a temperature range of 100-350 degrees C; and, 4) the selective copper anti-diffusion conductive film is formed by selective electroless plating.

23. It would have been obvious to one of ordinary skill in the art to have used nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; to have performed the annealing process using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process; to have carried out the plasma process in a temperature range of 100-350 degrees C; and, to have formed the

selective copper anti-diffusion conductive film by selective electroless plating, in the method of Saito, with the motivation that: 1) nitric acid is an alternate conventional cleaning solution to the HF used in Saito, for post-CMP operations. These solutions are wet etchants of the surface of the metal, which is how they clean the surface, so that either HF or nitric acid would further recess the surface of the copper wiring layer (See Toyoda et al. [0124] or Gupta et al. (col.4, lines 44-50 for acid wet etch to further recess a copper wiring); 2) the anneal being in the claimed temperature range and using rapid thermal anneal is within a reasonable range of temperature for the substrate considering the subsequent selective deposition conditions and time constraints to make the process efficient; 3) the electroless plating method is a conventional alternative to the selective deposition method taught in Saito.

24. Claims 3-6, 8-12, 15-18, 20, 23 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang et al. (US 6,387,806, dated 5/14/02) in view of Noguchi (US 2003/0114000, dated 6/19/03, filed 11/14/02).

25. Wang shows the method substantially as claimed and as described in the preceding paragraphs.

26. Wang lacks anticipation only in not teaching that; 1) a cleaning process is performed after the CMP step; 2) nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; 3) the annealing process is performed using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes in a rapid thermal annealing process, both in an inert gas or a mixed inert gas; 4) the plasma process is carried out in hydrogen and nitrogen, ammonia or hydrogen and an inert gas in a temperature

range of 100-350 degrees C; and 5) the copper anti-diffusion insulating film is formed by spin-on method and anneal in N2, Ar, H2 or He at 100 to 500 degrees C, using methyl, benzochlorobutane, polyimide, arylether and HSQ, which contain Si, C and N in a type of sol or gel.

27. Noguchi teaches, in a similar CMP process, a conventional post CMP cleaning step [0221] followed by an annealing step in H2 [0222] to reduce the copper oxide formation on the surface of the copper wiring layer and an acid cleaning of the substrate [0223]-[0237]. Plasma treatment is also discussed.

28. It would have been obvious to one of ordinary skill in the art to have cleaned the copper surface after the CMP step; to have used nitric acid for the cleaning process so that the copper wiring is further lower than the surface of the interlayer insulating film; to have performed the annealing process using a temperature of 100-500 degrees C or 200-700 degrees C for 1 to 5 minutes, both in an inert gas or a mixed inert gas, in a rapid thermal annealing process; to have carried out the plasma process in hydrogen and nitrogen, ammonia or hydrogen and an inert gas in a temperature range of 100-350 degrees C, in the method of Wang, with the motivation that: 1) cleaning after a CMP process in an acidic environment is conventional, as taught in Noguchi, and nitric acid is a conventional cleaning solution. Acid solutions are wet etchants of the surface of the metal, which is how they clean the surface, so that nitric acid would further recess the surface of the copper wiring layer (See Toyoda et al. [0124] or Gupta et al. (col.4, lines 44-50 for acid wet etch to further recess a copper wiring); 2) the anneal, being in the claimed temperature range and using rapid thermal anneal, is within a reasonable range of temperature for the substrate considering the subsequent selective deposition conditions and time constraints to make

the process efficient and considering the annealing/plasma parameters taught in Noguchi, as well as the anneal in H2, ammonia and N2 atmospheres taught in Noguchi in order to reduce the copper oxide formation, making the device more reliable.

29. It would have also been obvious to one of ordinary skill in the art to have formed the copper anti-diffusion insulating film by spin-on method and anneal in N2, Ar, H2 or He at 100 to 500 degrees C, using methyl, benzochlorobutane, polyimide, arylether and HSQ, which contain Si, C and N in a type of sol or gel, in the method of Wang, with the motivation that these are conventional passivation/diffusion layers, alternatives to the insulating passivation/diffusion layers taught in both Wang and Noguchi.

Conclusion

30. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. See the PTO 892 for very relevant similar processes.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynne A. Gurley whose telephone number is 571-272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on 571-272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Lynne A. Gurley
Primary Patent Examiner
TC 2800, Art Unit 2812

LAG
July 31, 2004